

Crew launch and exploration vehicle concepts

Top photo is an artist's rendering representing a concept of the crew launch vehicle on a launch pad.

A concept of rendezvous and docking operations between a crew exploration vehicle (CEV) and a lunar lander and departure stage.

Lunar lander undocks from the CEV while in moon-orbit. The CEV will remain unmanned while the astronauts descend in the lunar lander.

The CEV as it lands on Earth under its recovery parachutes (out of scene).

The Crew Exploration Vehicle actually consists of:

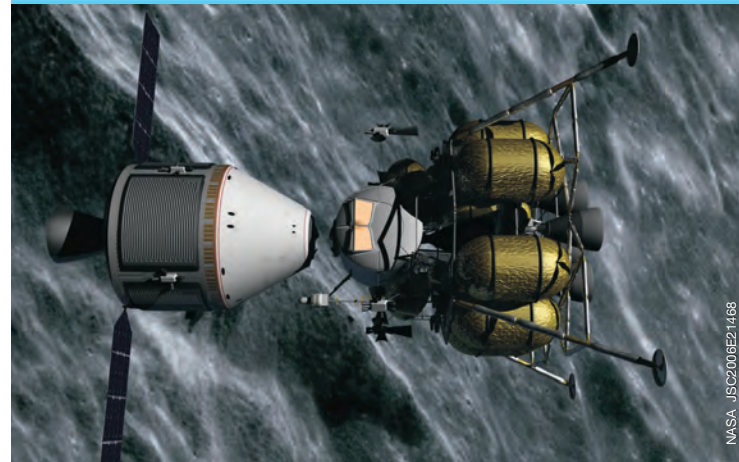
- the crew capsule
- a launch abort system that can rescue the crew at any time during launch
- a service module that contains thrusters for attitude control, an Earth-return engine, propellants and solar power cells
- a spacecraft adapter for connecting it to the Crew Launch Vehicle (CLV)

The adapter will connect the spacecraft to the CLV upper stage, which includes a shuttle-like tank and a modified J-2 engine from the Apollo era. That upper stage is mounted on top of a shuttle-like solid rocket booster with an extra fifth segment.

Instead of sending everything for a moon mission into orbit on one vehicle like Apollo, we'll use two. The second vehicle will be a heavy lifter that carries the Earth Departure Stage and its J-2X engine, the lander and surface support systems into orbit. Two five-segment solid rocket boosters and five RS-68 liquid hydrogen/liquid oxygen engines will power the Cargo Launch Vehicle.

For lunar missions, which we plan to start no later than 2020, the Cargo Launch Vehicle will launch first. Then, the CEV/CLV will launch with the crew. The CEV and service module will rendezvous and dock with the lander and Earth Departure Stage in Earth orbit before beginning the trip to the moon. We're planning shorter, week-long missions to the moon at first, but we're looking at ways to leverage the hardware we put on the surface for longer missions as we build up to a sustained presence on the moon's surface. We'll test the CEV and CLV early in the next decade and then make shakedown mission to the station starting no later than 2014.

The Apollo guys did a lot of work analyzing the safest and most efficient shape for ascent and entry. They decided the Apollo capsule shape was optimal. Since the physics of spaceflight haven't changed in 40 years and the Apollo shape had a proven track record, the ESAS team recommended this same shape over several other possible configurations. More detailed analysis by the Constellation team subsequent to ESAS has further supported the conclusion that even a larger version of the Apollo capsule is still the preferred shape for ascent and entry.



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4 What happened to using the space shuttle main engines and liquid oxygen/liquid methane propellant choice proposed in ESAS?

It's normal for programs to make these kinds of changes in the early stages. The Apollo program made numerous major design changes before settling on the configuration that flew. The original ESAS idea was to make use of current shuttle and legacy Apollo systems to build something that would be 10 times safer than the shuttle. As Constellation has taken a closer look at technical trades, we've seen areas where it made sense to change in order to benefit interoperability and long-term affordability. I'm sure there will be more changes in the months and years ahead as the vehicle designs and mission plans mature. We compared the shuttle engines to other rocket engines available, and came to the conclusion that a modified version of one used in Delta IV rockets would be half as expensive to update and build. As for "green propellants," we haven't ruled them out; we've just decided not to mandate them for early missions because of anticipated development time and cost. We're hoping that our prime contractors will offer a way to build them in at some point.

5 When will we fly the first Constellation missions?

This is a go-as-you-pay program, so that depends on the amount of funding we receive from Congress and the administration. With our current funding profile, we're on track to meet or improve upon a first CEV launch with astronauts by 2014, and a first crewed moon mission by 2020. We are working hard now to make smart decisions on how to apply limited funding so that everything will come together at the right time. We have recently begun planning for our first test flight of the CLV, which might occur as early as April 2009.

6 What is JSC's role in the program?

JSC is hosting the program office, the CEV Project Office and the Mission Operations Project Office. The Constellation Program manages and integrates the program and all projects, just like the Space Shuttle Program does for the shuttle and the International Space Station Program does for the station. The CEV Project manages and integrates all CEV elements, including prime contractor work, in the same way the Orbiter Projects Office manages the orbiters. The Mission Operations Project manages and integrates all activities related to Mission Operations, including flight operations, crew training and the mission control center for human exploration missions. In addition, we're using our formidable in-house expertise at JSC to design the cockpit and to build some key components for the crew vehicle, such as a Low-Impact Docking System for lunar missions and the parachute systems for landing.

7 How do the other NASA centers fit in?

In June, we announced the work assignments being given to the NASA centers. We're going to use all available resources and capabilities to provide a U.S. crew launch capability replacement as soon as possible after the shuttle retires. We're trying to maximize the use of existing facilities and technical expertise across the agency and provide a template for future work assignments. We're trying to synchronize the work around the agency to minimize program costs and mitigate program risk. In a nutshell, each center will contribute as it is best qualified. We're going to continue to refine these plans to keep them consistent with the overall agency budget plan.

8 Are you coordinating the transition to the new vehicles with the shuttle and station programs?

Yes, we are. I'm working closely with Wayne Hale and Mike Suffredini to make sure we don't spend money on the same thing twice and that we have a smooth transition from the shuttle era to the Constellation era. And at the same time, Scott Horowitz and Bill Gerstenmaier are working closely with one another. There are some tricky issues associated with this kind of transition. And all three programs are working on limited budgets. The Constellation Program is not going to immediately start paying for everything we do in human spaceflight. The transition will be a gradual process, with Constellation Program funding ramping up as Space Shuttle Program funding tapers off. But we're talking through these issues and documenting our decisions.

9 When will we select a prime contractor for the CEV?

The source evaluation board is going over the proposals submitted by the two bidders—Lockheed Martin and the Northrop Grumman and Boeing team. We expect to make a final selection in early September.

10 What do you see as the biggest challenge facing your team?

I want to see humanity—see America—go to Mars. So the biggest challenge I see is creating a transportation system that's affordable and sustainable. We have to significantly cut the cost of getting mass into orbit, because every pound we put on the surface of the moon will cost us much more than just getting into Earth orbit. And we have to do it with a budget that is less than 1 percent of the federal budget, not the 4 percent that Apollo had. And we're going to have to keep reminding ourselves that we're setting the table well for the generation that will go to Mars. We need to give them a foundation at least as good—if not better—than the Apollo generation bequeathed to us.

Along for the ride

Tram tours give visitors a glimpse into space program



by Brad Thomas

THROUGHOUT the years, Johnson Space Center has been the site of many historical events, and many more will follow as the Vision for Space Exploration takes off. Since the public has limited access to the center to see the groundbreaking work done here, the best opportunity is through Space Center Houston's tram tour.

Space Center Houston is the official visitor center adjacent to JSC. More than 750,000 people visit Space Center Houston each year, and more than 500,000 of those visitors choose to take the tram tour.

Space Center Houston Operations Manager Anson Brantley said the organization operates at least one tram tour per hour and as many as one every 10 minutes.

"We have the capacity to put 4,800 people a day on the tram tour," Brantley said.

A normal tour lasts 60 to 90 minutes. Brantley said the amount of time and the number of tours depends on the number of stops on the schedule and the number of people wanting to take the tour.

The stops on the tour include the historic Mission Control Center (MCC), the training facilities in Building 9, Rocket Park and the Memorial Tree Grove. Due to mission schedules and other considerations, not all of the stops are available every day.

"Mission Control is always a great building to visit," Brantley said. "We are excited to have the Saturn V Facility open."

Space Center Houston is a popular destination for groups, especially students. A large group of middle-school students from the Lone Star Leadership Academy recently took the tram tour.

It was the second trip to Space Center Houston for Leadership Academy director Christin Siller. She said the tram tour allows people to get a better sense of the current happenings within the space program.

"To be able visit the space center allows you to put things in perspective," Siller said. "You can feel the history."

The tour begins with the tram snaking down a path from Space Center Houston's main building and through a tunnel under Saturn Lane to the grounds of JSC. During this stretch, the tour guide begins to give an oral history of the space center.

Ironically, it is not symbols of technology that first greet the tram riders: They are instead welcomed by a brilliant display of wildflowers and Texas longhorns near Rocket Park.

After passing Rocket Park, the tram heads to its first stop: Building 30. The group enters the building and makes its way up 87 steps to the historic MCC observation room. The room overlooks one of the original Mission Control rooms, which still contains computers from the Apollo days. The audience then listens to a presentation on the history of MCC by one of Space Center Houston's volunteers.

The visitors then reverse course and head back to the tram for the ride to Building 9.

Before going up to the Building 9 observation deck, the group watches a video describing the facility and its activities.

From the observation deck, visitors get an impressive view of mockups of present and future International Space Station components. As the walking tour progresses, they pass by space

shuttle mockups before arriving at the area where robotic arm simulations take place. If the timing is right, those on the tour can see engineers working or astronauts training in the facility.

The next stop for the space buffs is in front of the Memorial Tree Grove. It is here that visitors learn about the ultimate sacrifice that some have made in the name of exploration. The riders are given a description of the site and then hear an excerpt of President George W. Bush's speech from the Space Shuttle *Columbia* memorial service in 2003.

Siller said she was moved by this part of the tour. "I think it is a great way to end the program," she said. "It allows you to get a sense of the importance of the (space) program. Listening to President Bush's speech allows you to be proud of the sacrifice."

The next stop for the riders is Rocket Park. Here, visitors are given a choice: stay on the tram and head back to Space Center

Houston, or check out the rockets at Rocket Park, including the recently refurbished Saturn V.

Flora Hollifield, an eighth-grade student from Dallas, said she enjoyed the history associated with the tram tour. She singled out historic Mission Control as her favorite stop because of its authentic Apollo-era equipment. "I like the Mission Control room," Hollifield said. "I like that they kept all of the computers."

Space Center Houston and the tram are also a big hit with families. Jimmy and Anna Baker of Santa Fe, Texas, took their grandson Jeremy for a visit. Jeremy said the MCC was the most interesting part of the tour.

His grandfather agreed. "The speaker was really good," he said. "It brought back a lot of memories."

Clockwise from left: An employee drives a Space Center Houston tram past JSC's Rocket Park.

Visitors learn about Building 9's training facilities before heading up to the observation deck.

Even covered in plastic, the Saturn V rocket makes quite an impression. The plastic will remain until all interior work is complete.

